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COMPARATIVE STUDY OF MANUAL AND MECHANICAL RICE PUFFING METHODS

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ABSTRACT

Puffed rice is a popular snack food product in India and has been widely produced for centuries. It has been estimated that about 10% of rice is converted into snack foods. In order to understand the rice puffing technology and to know how the different parameters influencing the puffed rice making process, the present investigation “Comparative Study of Manual and Mechanical Rice Puffing Methods” has been under taken in the Dept. Processing and Food Engineering, College of Agricultural Engineering, UAS, Raichur during the year 2012-13. The comparative between manual and mechanical methods for different parameters viz., parboiling, effect of milling, pre-treatment, addition of salt, roasting, puffing operations were depending factor on quality of raw material. The maximum expansion ratio of 12.50 was recorded for puffed rice obtained from mechanical puffing method as compared to manual puffing method (11.8). The efficiency of manual rice puffing unit is less than that of mechanical puffing unit. The capacity of puffed rice production in manual method is less (50 kg/h) than that of mechanical puffing method (100 kg/h). The drudgery involved in the production of puffed rice in manual rice puffing unit is more as compared to mechanical puffing method. There is no significant difference between the taste and quality of puffed rice obtained from manual and mechanical rice puffing unit.

KEYWORDS: Puffed rice, Parboiling, Expansion ratio, Mechanical puffing method and Puffing unit.

INTRODUCTION

Rice is the staple food for 65% of the population in India. It is the largest consumed calorie source among the food grains. With a per capita availability of 73.8 kg, it meets 31% of the total calorie requirement of the population. India is the second largest producer of rice in the world next to China. India produces annually around 93 Million Tons of rice (2012-13). It is estimated that about 10 per cent of food grains produced in India are lost in processing and storage. It has been reported that about 9 per cent of rice is lost due to use of old and outdated methods of drying and milling, improper and unscientific methods of storage, transport and handling. It has been estimated that total post-harvest losses of rice at producers’ level was about 2.71 per cent of total production.

Rice quality comprises its size, shape, color, aroma and milling, marketing, nutritional, cooking, eating and product making qualities. Many of these are related to the physical features and only need measurement and classification.

Cooking, eating and product making qualities of rice, however, related to its different engineering parameters, the cause of effect on relations of which have remained a mystery till date (Juliano, 1985b). It is mainly consumed after cooking in water to a soft fluffy product. During cooking, it absorbs about 2.5 to 3 times its weight of water. Cooked rice cannot be preserved for more than a few hours. Hence, the cooked rice, have been developed to improve storage, and increase consumer acceptability.

The processing of puffed rice from paddy is traditionally takes about 6 days. Some of the tasks, particularly manual roasting of paddy and immersing in water, mixing the ingredients with milled rice and stirring the rice in roaster pan for uniform heating are highly labour intensive operations. Complete mechanization of the process has not yet been undertaken. Many of the rice puffing units are of the traditional type and are inefficient. Modern rice puffing machines are having high capacity and are capital intensive, although efficient.

In order to understand the rice puffing technology and to know how the different parameters influencing the puffed rice making process, the present investigation on "Comparative Study of Manual and Mechanical Rice Puffing Methods" has been under taken to compare the different operations in manual and mechanical puffing methods.

Murugesan and Bhattacharya (1986) studied the effect of various processing conditions on puffing, using a small laboratory coffee roaster, and a small hot air puffing system using 25 g paddy in each experiment. The optimum conditions were; grain moisture of 14 per cent (wet basis) in either system and sand puffing at about 200°C and air puffing at 225°C at an air-flow rate of 1.5 m 3 min. Immature kernels did not puff well, but cracked grains showed slightly increased puffed volume. Parboiling reduced puffing. Addition of salt increased puffed volume, appreciably and also shifted the optimum moisture content to 17 per cent.

Lin and Anantheswaran (1988) determined the optimum processing conditions, and characteristics of five popcorn varieties for better popping performance in a microwave oven. In every variety, the range of optimum moisture content resulting in maximum expansion volume was found to be different from that for the minimum number of unpopped kernels. Under the optimum moisture contents M-045 yielded the highest expansion volume and IOPOP12 had the lowest unpopped kernel ratio. Large kernels within the variety M-045 yielded the highest expansion volume and IOPOP12 had the lowest unpopped kernel ratio. Surface damage to kernels reduced the expansion volume drastically. The effect of salt and oil on the popping performance of popcorn was complex.

Bhuvaneshwari (1999) studied the effect of bulgarisation on popping quality of ten different wheat varieties. The expansion ratio of bulgarized popped wheat of different varieties varied significantly, the highest expansion ratio was in DDK1-3 and lowest in DWR-185. On bulgurization the expansion ratio increased when compared to raw popped wheat varieties. Whereas, bulk density of raw popped wheat was significantly higher in all the varieties when compared to bulgurized popped wheat.

Zheng and Lan (2007) the influence of drying temperature on rice taste quality was studied in this paper. The heated-air temperature of 40℃, 45℃, 50℃, 55℃, and 60℃, respectively, were used to dry fresh paddy. The critical drying temperature of 45℃ for paddy rice with an initial moisture content of 21.36% w.b. was obtained, which induce the rice taste value declining significantly. Also, the amorphous starch matrix inside the rice kernel, which takes the shape of hardly dissolved starch granular, was observed by electron microscope. The fatty acid content of the rice increases as the drying temperature, which results in a higher degree of rice aging and restrains starch gelatinization during rice cooking. In

order to preserve rice taste quality, a drying temperature below 45℃ is recommended for drying paddy, if its initial moisture content is less than 21.36%. The relationship between the major rice ingredients vizprotein, amylase and moisture. SuchadaMaisont and WoatthichaiNarkrugsa (2009) reported the effects of salt, moisture content and microwave power on the puffing qualities of puffed rice were investigated. Paddy rice was adjusted with water and 2% salt solution at four moisture levels 10, 13, 16 and 19% (w.b) and puffed with microwave power at 600, 700 and 800 watts. The results showed that all the main factors and their interactions significantly ($p<0.05$) affected the puffing qualities of total puffed yield, fully puffed yield, small puffed yield, expansion volume, texture, color and microstructure. Puffing paddy rice at 19% moisture content with 600-700 watts produced the highest fully puffed yield, but the lowest total puffed yield. The results suggested that high puffed yield and expansion volume with moderate hardness was produced using soaked paddy rice at 2% salt solution, 13% moisture content and puffed with 700 or 800 watts microwave power.

MATERIALS AND METHODS

The materials used and methodology adopted for the comparative studiesof manual and mechanical rice puffing methods are given below.

Raw Materials

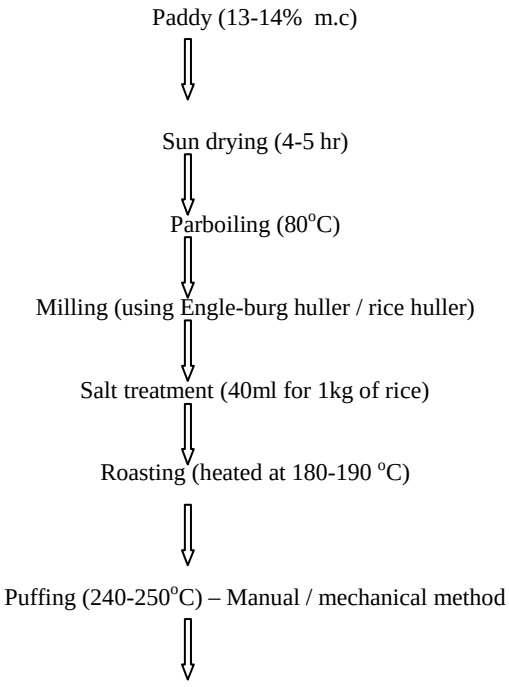
The raw materials of parboiled rice of variety IR-64 were procured from different puffing units of M/S. Govinda Reddy and M/S. Brahmananda, Raichur for conducting physical properties

Compare the different Operations in Manual and Mechanical Puffing Methods

The study were undertaken to compare a manual and mechanical puffing methods in different places ofRaichur. A base line survey was carried out with a set of questionnaires. This helps to understand the process parameters in both the methods. The details of the process chart and its methods were discussed in the following sub sections.

Process flowchart of rice puffing

The different unit operations involved in of rice puffing for manual and mechanical methods as shown in Fig. However, puffing depends upon the pre-treatment conditions, accordingly the process methodology may be altered.



Puffed rice

Sun Drying

Sun drying is the traditional method for reducing the moisture content of paddy by spreading the grains in the open yard. In this method, paddy are spread in thin layers, 2 to 4 cm but less than 5 cm on the floor. To get the required moisture content, grain temperature and moisture content were monitor by using thermometer and moisture meter. Shade drying is practiced whenever a temperature goes beyond 50ºC (42ºC for seeds). The final moisture content of dried paddy around 14%.

Parboiling of Paddy

Parboiling of paddy is a hydrothermal process in which the starch granules within the rice grain are gelatinized by the application of steam and hot water. For which cleaned, dried paddy (13–14% moisture (w.b.)) is taken and it is soaked with the equal proportion of heated water of 80°C and left over night. Next day after draining the water, steam of 125 -130 °C is passed for 10 min and dried under natural condition (Battacharya, 1986).

Milling of Paddy

The basic rice milling processes consists of pre cleaning to remove all impurities such as small stones and unfilled grains from paddy, husking to removing husk from paddy, aspiration to separate the husk from brown rice, separation of unhusked paddy from brown rice and whitening to remove bran layer and germ to a required level.

Salt Treatment

Salt treatment is the one of the pre-treatment method of puffing of the milled rice. It is mainly done to get maximum expansion ratio and for tasty puffed rice. For the preparation of salt solution salt, cooking soda and water are used. In manual puffing method salt solution will be added in two times, For the first treatment, 100 g of cooking soda, 4 kg of salt mixed with 25 lit. of water for 100 kg of rice. This is method were practicing before conditioning of the rice. For the second treatment, 100 g of cooking soda, 1.25 kg of sugar and 5 kg of salt in 18 lit. of water were mixed into the rice during roasting prior to puffing.

Roasting

Roasting is a method of drying to treat the rice to get optimum moisture content during puffing operation. In this process salt treated rice was roasted for 8-10 min. at the temperature of 180-195 ^{o}C in four separate pans which are meant for roasting of salted rice. Roasting is done by constant stirring of rice by mechanical stirrer rotating at 40-60 rpm. In mechanical puffing method, roasting operation done in cylinder contains fins all around the periphery.

Puffing

Puffing is a process of expanding the rice kernels by exposing the kernels to a high temperature for short time. In this process, the roasted rice were exposed to a higher temperature of around 240-250 ^{o}C for short duration of time (5-10 s). In the manual method of puffing, this will be done in separate pan, around 200 g of roasted rice is used for puffing

operation. Puffing takes place 5-7 s with a temperature of 240-250 oC maintained with the help of sand. One labour is required for this operation. The puffed rice will be separated with sand by using manual sieving.

In mechanical rice puffing method, puffing is done in the cylinder with the expose of high heat treatment of 240-250 °C for 4-5 s. One end of the cylinder contains dome shaped structure which in turn helps in sudden expansion to the rice with high temperature and other end attached with sieve for removal of sand.

Manual operation of rice puffing

The manual operation of rice puffing is shown below. All the puffing activities were carried out manually viz., conditioning, roasting, puffing etc. The manual puffing machine consists of five metal pans fixed on the ground below, which a heating furnace is provided, stirrers are provided for all the 5 pans with the help of external frame.

Table 1: Different Parts and Description of the Manually Operated Puffing Machine

Sl. No.	Parameters	Description
1	Frame	1 No.
2	Pans	5 No.s
3	Diameter	60 cm
4	Depth	30 cm
5	Stirrer	5 No
6	Length	30 cm
7	Motor	1 No (1 hp)
8	Sieve	1 No
9	Aperture size	5*5 mm
10	Furnace	1 No
11	Power transmission	Motor and pulley (1 No)

Figure 1: Manual Method of Puffing of Rice

Mechanical Operation of Rice Puffing

The mechanical rice puffing machine is shown below. All the puffing activities were carried out mechanically. The basic parts of the machine are hopper, cylinder, baffles, fins and motor

Figure 2: Mechanical Rice Puffing Unit

Table 2: Different Parts and its Description of the Mechanical Puffing Machine

Sl. No.	Parameters	Description
1	Hopper	1 No.
2	Cylinder Length	1 No. 225 cm
3	Shaft Length Diameter	1 No. 375 cm 6 cm
4	Furnace	1 No.
5	Motor	2 No.

RESULTS AND DISCUSIONS

Comparative of Manual and Mechanical Methods

Effect of Parboiling

Effect of parboiling is evident in rice puffing operation. Parboiling has direct impact on the quality of puffed rice obtained after puffing. It mainly gelatinizes the starch and removes the air pockets contained in the kernels which intern helps in dissipation of heat in all the directions so as to get uniform puffing. It helps in higher percentage of head rice recovery. Parboiling rice drives nutrients, especially thiamine, from the bran into the grain, so that parboiled white rice is 80% nutritionally similar to brown rice. It reduces breakage in milling, improves storage life and helps in the preservation of protein and vitamins in the rice. It is commonly considered that any parboiled rice is suitable for the expansion by heat. However, Roberts et al., (1954) who tested steaming soaked paddy at various temperatures between 65°C to 140°C, noted that the expansion ratio of the resulting milled rice remained minimal upto the steaming temperature of about 100°C, then raised upto 125 °C and balanced accordingly to obtain maximum puffed rice.

Effect of Milling

The expansion ratio of puffed rice obtained from rice samples having different degrees of milling increased to a certain value and then stagnated. It was observed that a minimum of about 6 degree of milling was necessary to produce optimum expansion of puffed rice, beyond the degree of milling showed no appreciable effect on expanded rice. This might be due to the higher resistance offered by the existing bran covering at a lower degree of milling against the spontaneous release of high-pressure steam formed inside the grain at the time of puffing.

Effect of Pre- treatments Conditions on Puffing

In both the cases the rice was pre- treated with hydro-thermal treatment before the treated rice exposed to 240-250°C for actual puffing operation. The purpose of hydro thermal treatment is to increase the humidity inside the kernel center and formation of dry solid layer on the kernel surface. This creates miniature pressure vessel that can work as puffing gun i.e. inside the kernel as water over heats and rupture of surface expansion occurs.

Effect of Salt Addition on Puffing of Rice

Salt solution is invariably added to milled rice before it is expanded in the industry. The effect on expansion was investigated by Chinnaswamy and Bhattacharya (1983) and stated that salt appreciably increases the expansion ratio. In his study, heat expansion of cooked starch postulated that salt helped the expansion by facilitating the heat conduction inward and the exit of moisture outwards. It is interesting to note that, while salt increased the expansion ratio of both steam-parboiled and dry heat- parboiled rice, an uneven blistered surface but the latter was smooth.

Since soaking of paddy in 2% NaCl solution increased its popping expansion by about 15%, it was investigated whether salt soaking and pre- drying could be combined for a greater benefit. The expansion was indeed raised over that of unsalted paddy and remained high up to a moisture content of 17% – the optimum for popping salt-soaked paddy.

Effect of Roasting on Rice Puffing

As per the study conducted by Chinnaswamy and Bhattacharya (1983), roasting of pre- treated rice at about 240 to 250°C is essential for sudden expansion of rice in to puffed rice. Sudden exposure of entire kernel to the high temperature (6-10 sec) reduces the moisture to 1-2 %.

Puffing Operation by Manual Puffing Unit

The puffing operation involved in manual method is of batch type requiring 2 labours to complete all operations. With the available set of manual puffing unit, the capacity ranges between 50 kg/h and the BC ratio is of about 1.09. It is laborious process and leads to higher degree of drudgery.

Puffing Operation by Mechanical Puffing Unit

In mechanical operation it is continuous one having the capacity of 100 kg/hr. As all operations are performed in the cylinder with in the four walls, the drudgery involved is less as compared to manual method. The demerit of this unit is higher capital investment but no significant difference in BC ratio as compare to manual method.

SUMMARY AND CONCLUSIONS

- Maximum expansion ratio can be obtained with the rice having maximum length-width ratio.
- The maximum expansion ratio of 12.50 was recorded for puffed rice obtained from mechanical puffing method as compared to manual puffing method (11.8).
- The efficiency of manual rice puffing unit is less than that of mechanical puffing unit.

- The capacity of puffed rice production in manual method is less (50 kg/h) than that of mechanical puffing method (100 kg/h)
- The drudgery involved in the production of puffed rice in manual rice puffing unit is more as compared to mechanical puffing method.

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